Test Beams: Essential to Forging New Detector Technologies

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Test Beams For RHIC/eRHIC

- Test Beams Provide:
  - An opportunity to develop new detector technologies
  - Refine detector designs
  - Evaluate system performance
- Looking at past test beam efforts provides insight about what is needed for a high quality test beam in the future.

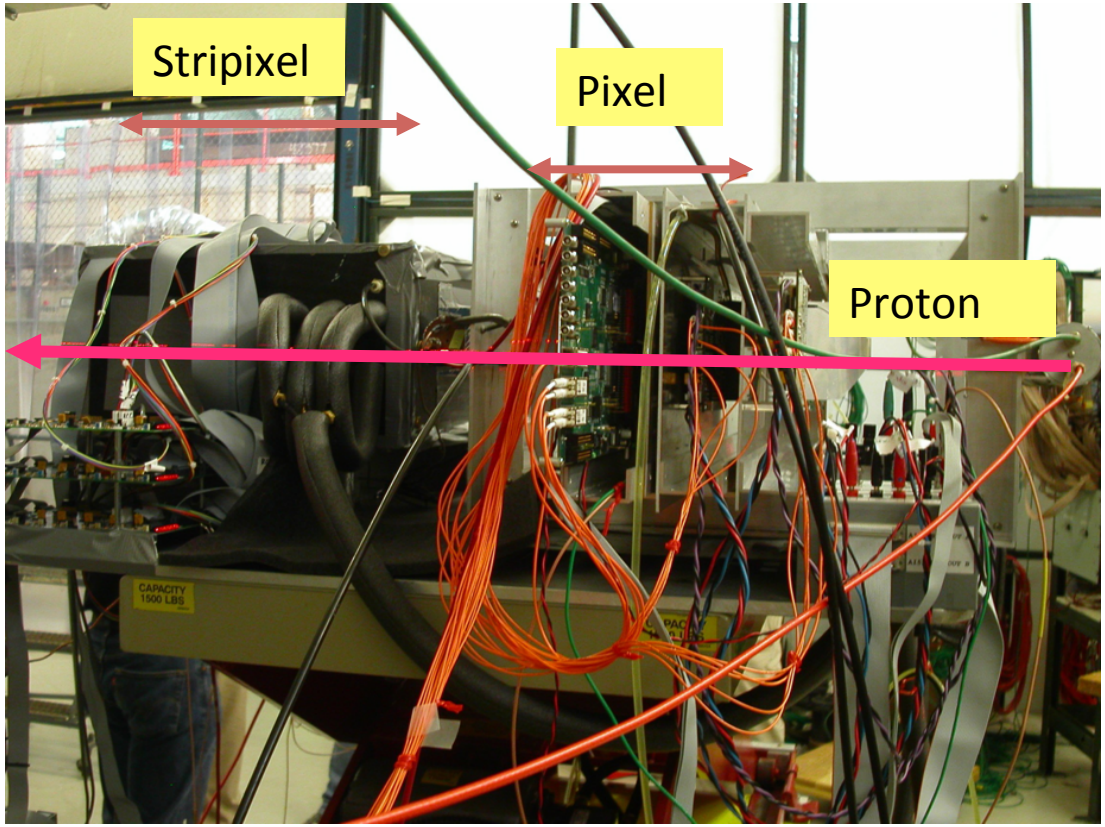
PHENIX Test Beam Efforts

- FNAL T-948: Silicon Tracking (Aug 2008)
- CERN : PHENIX HCal Prototype (Dec 2012)
- FNAL T-1038: MPC APD and MPC-EX Tests (Sept 2013)
- FNAL T-1044: sPHENIX Calorimetry Tests (Feb 2014)
- FNAL T-1048: PHENIX Fast TOF (Feb 2014)
- FNAL T-1054: sPHENIX Preshower (Feb 2014)
- SLAC: MPC-EX Testing: (June 2014)

STAR/eRHIC Test Beam Efforts

- FNAL T-963: STAR Muon Telescope Detector (May 2007)
- FNAL T-1018:UCLA Spacordion Tungsten Powder Calorimeter (Jan 2012/Feb 2014)
- FNAL T-1037: FLYSUB Consortium (Oct 2013/ Feb 2014)
- …

T-948 @ FTBF



FERMILAB Meson Test area

120 GeV Proton

5-30mm beam spot

4.5 sec spil per 1 min.

2×10^{10} proton / spill

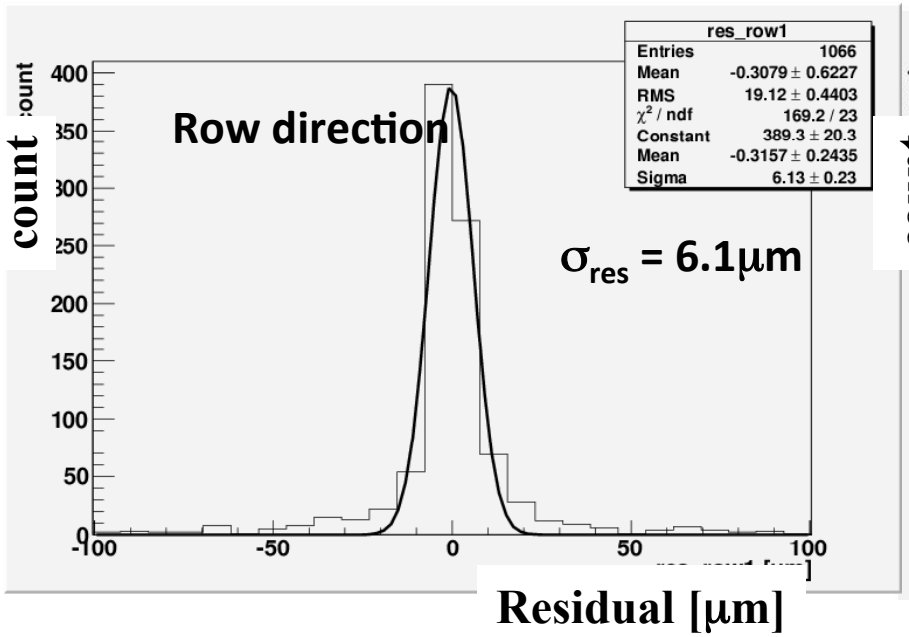
3 Prototype pixel ladders

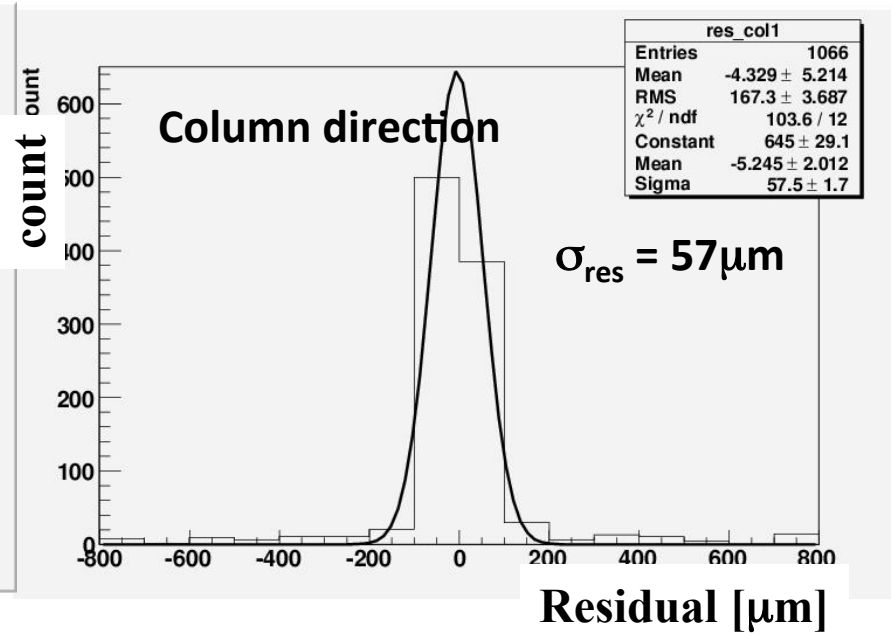
3 Prototype StriPixel Sensors

Trigger: Beam defining Scintillators.

A. Takatani @ RIKEN

T-948 Pixel Performance





Un-convolute

Fit include all 3 layers hit position

Multiple scattering effect

→

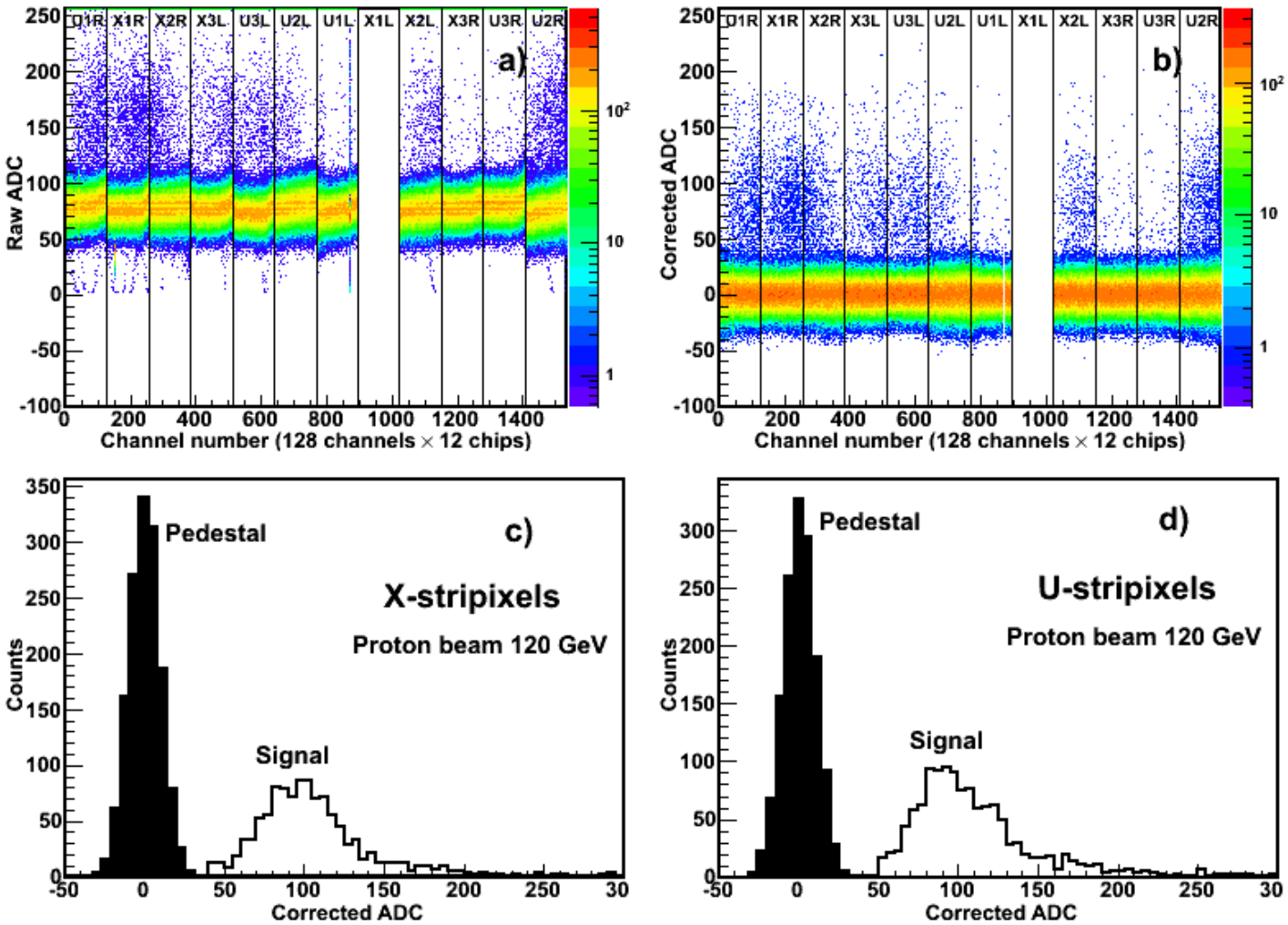
Intrinsic resolution

row : 14μm

column : 152μm

A. Takatani @ RIKEN

T-948 StriPixel Performance



T968/T-1037@FBTF

T-968: STAR MTD

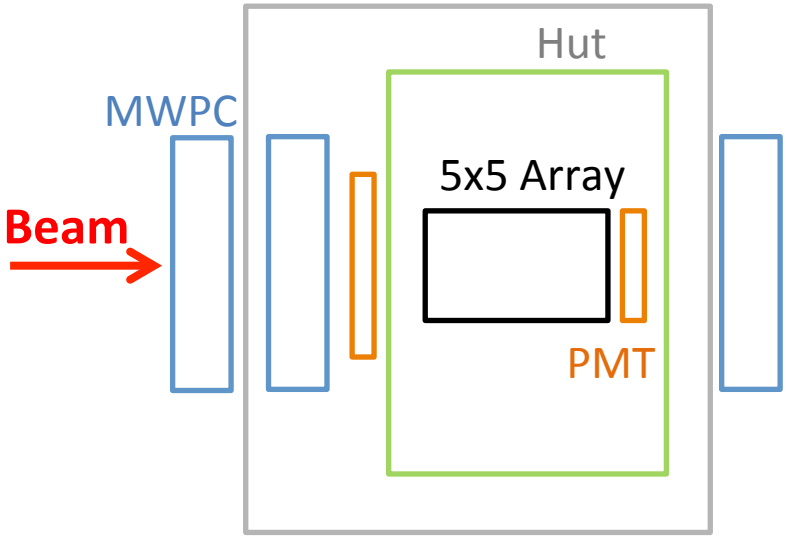
- Test prototype electronics, MRPC Strips and Wire chambers prior to installation at STAR
- Beam:
  - Pion, Muon, Proton
  - Intenisty < 1kHz
  - Spot size: 1-10 cm^2

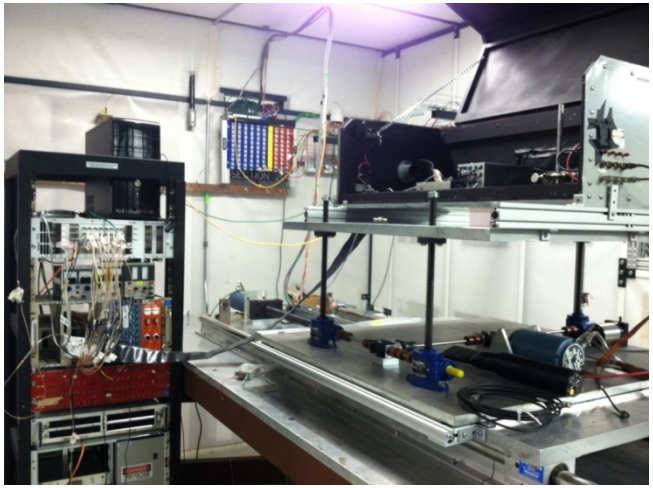
T-1037: FLYSUB Consortium

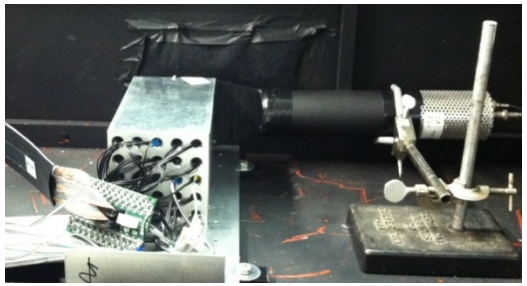
- Tracking and PID for an eRHIC detector
  - GEMS
  - Cerenkov dectors
  - Readout electronics
- Beam
  - Electronics
  - Intenisty < 1kHz
  - Spot size: 1-10 cm^2

T-1038 @ FTBF

- Low energy Pions for MIPs: 1-32 GeV
- 5x5 array of MPC crystals with APDs on front



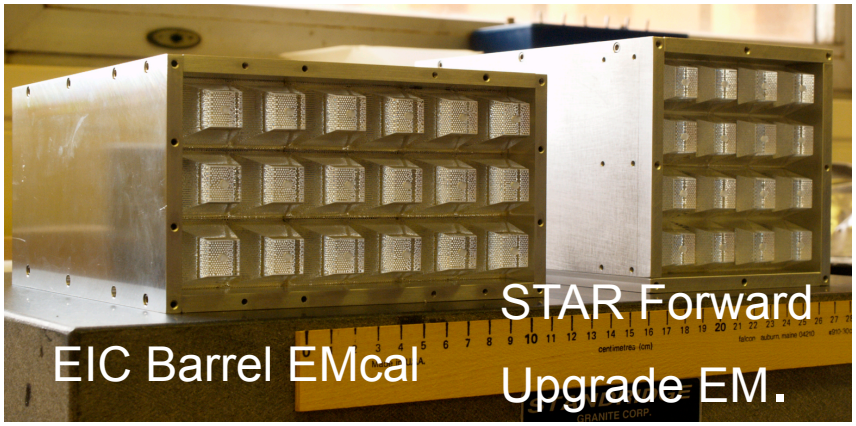


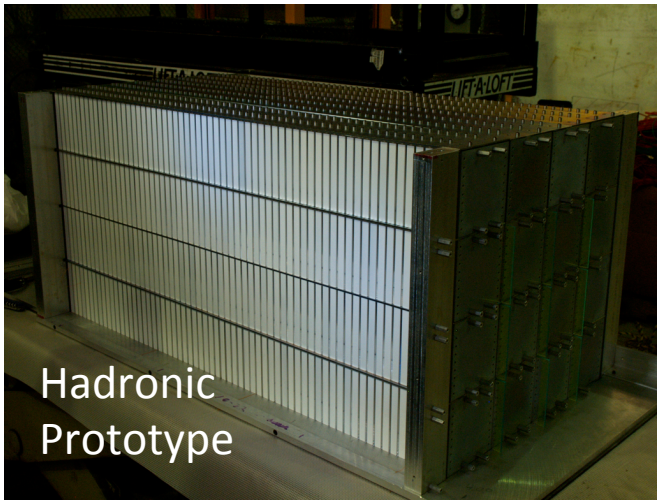


S. Campbell @ ISU

T-1018 @ FTBF

- STAR/eRHIC Hardonic/ Electromagnetic Calorimeter
- Multiple runs in 2012/2014
- Electron beams from 1-30 GeV
- Low Rates
- Small Beam Spot

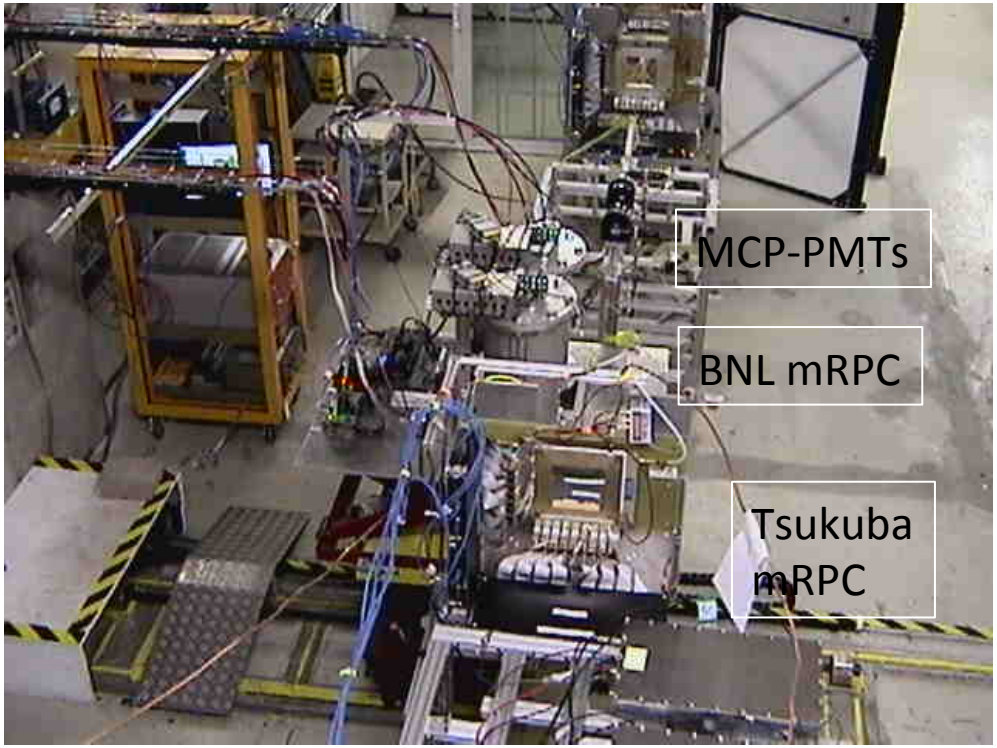




O. Tsai @ UCLA

T-1048 @ FBTF

- Pico-Second TOF for RHIC/eRICH



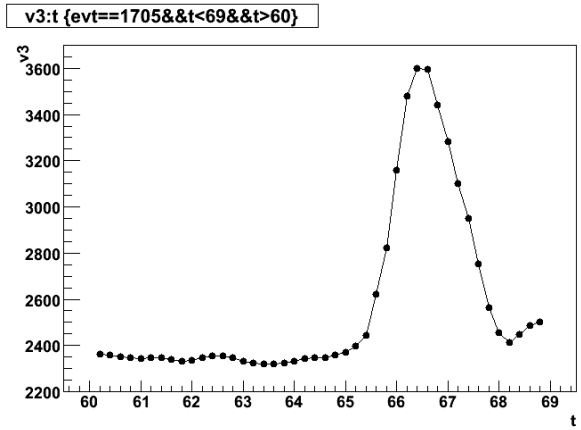
M. Chui @ BNL

Ran at FTBF in Feb 2014

- 120 GeV Proton
- Low intentisty

Analyze the time resolution and efficiency as a function of:

- High voltage
- Vertical position
- Gas mixture ratio
- Gain of pre-amp

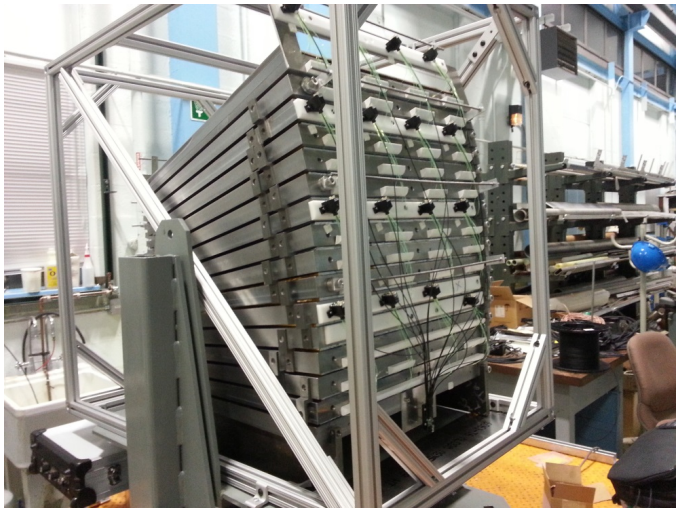


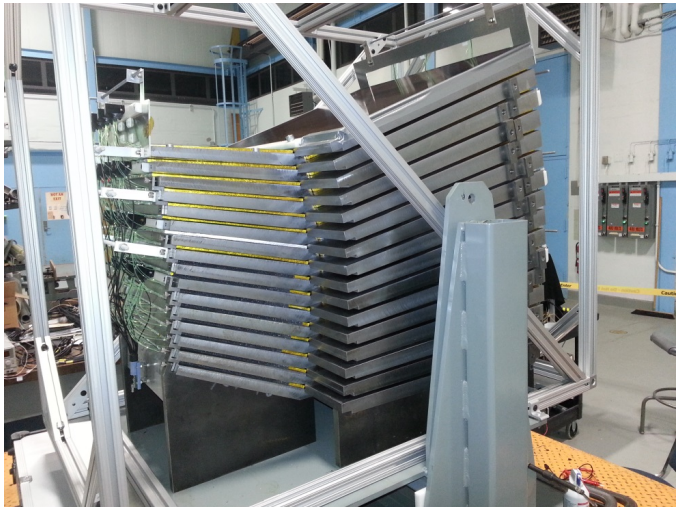
T-1048 Setup @ FTBF

T-1044 @ FTBF

T-1044 @ FTBT

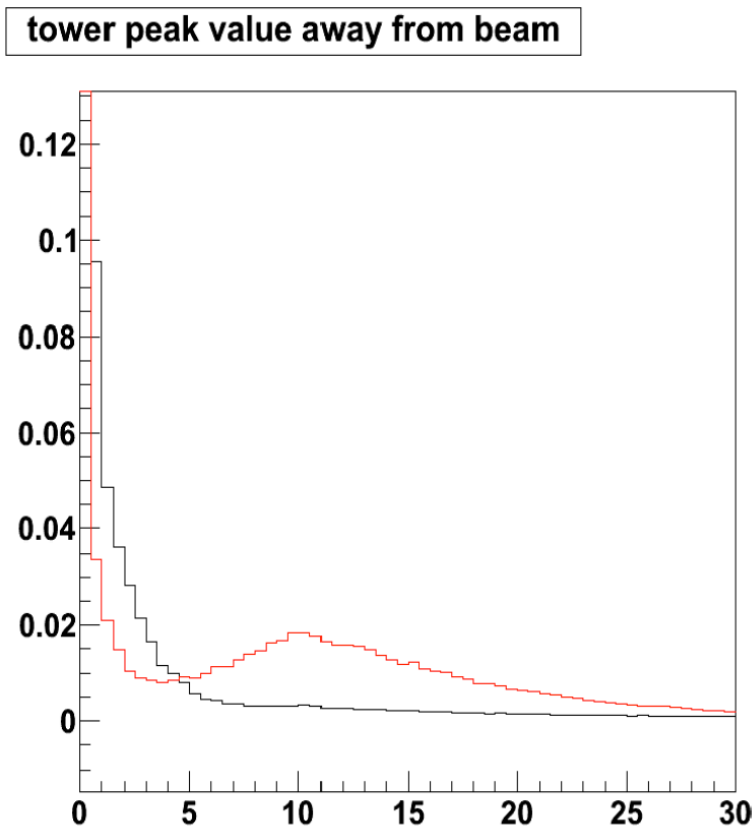
- Ran in Feb 2014 for ~ 3 weeks
- Electromagnetic and hadronic calorimetry
- Beam:
  - 120 GeV Protons
  - Mixed Beam (e/π/μ/p) from 1-30GeV
  - 10^{10} particles/spill
  - Shared time with T-1048 and T-1054

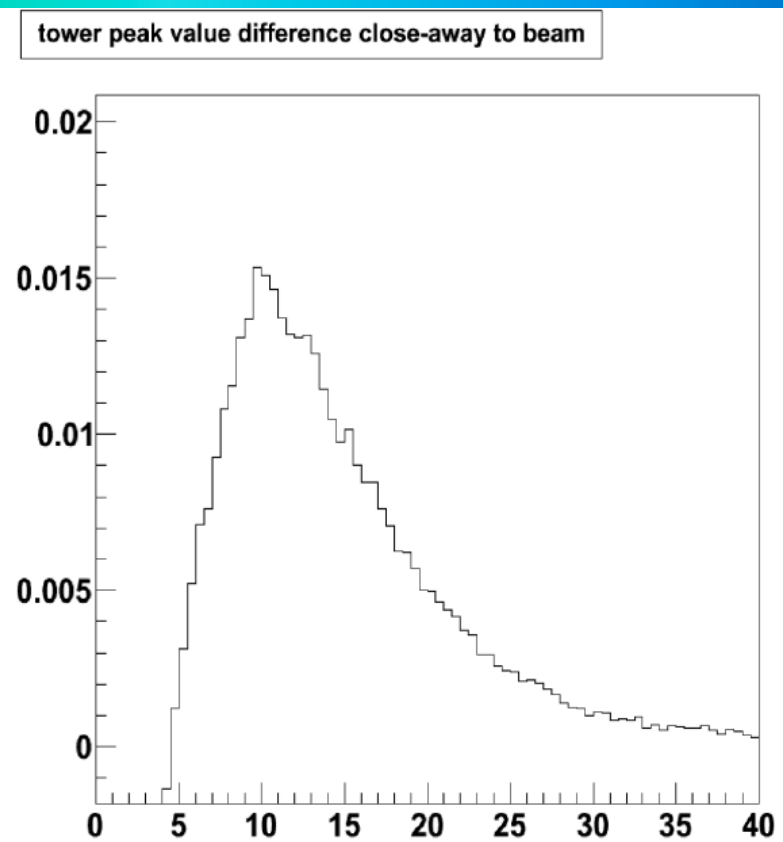




MIP Peak in the EMCal

120 GeV protons





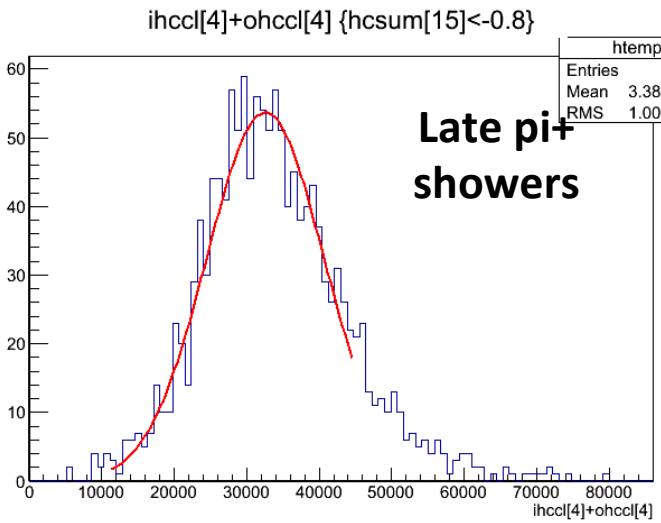
Achim F.

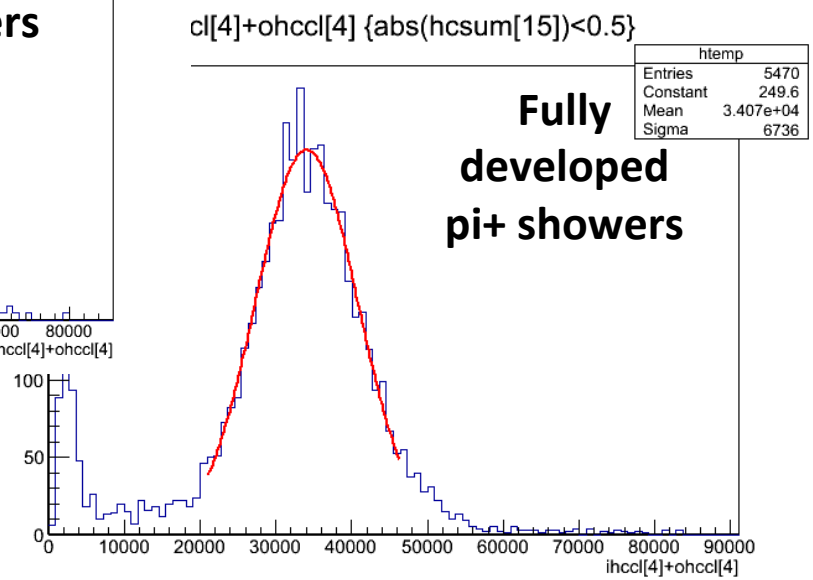
C.Woody, sPHENIX Workfest - EMCAL, 4/1/14

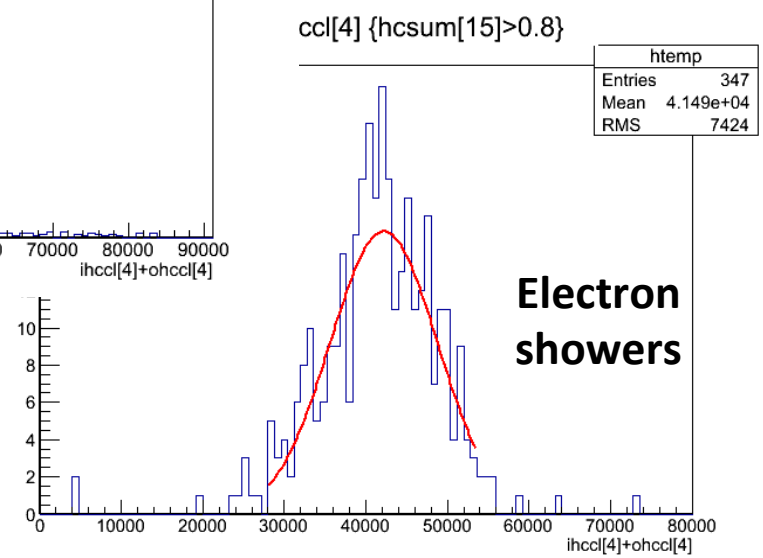
C. Woody @ BNL

32 GeV/c π^+/e Hcal Data

32 GeV/c
Raw spectra



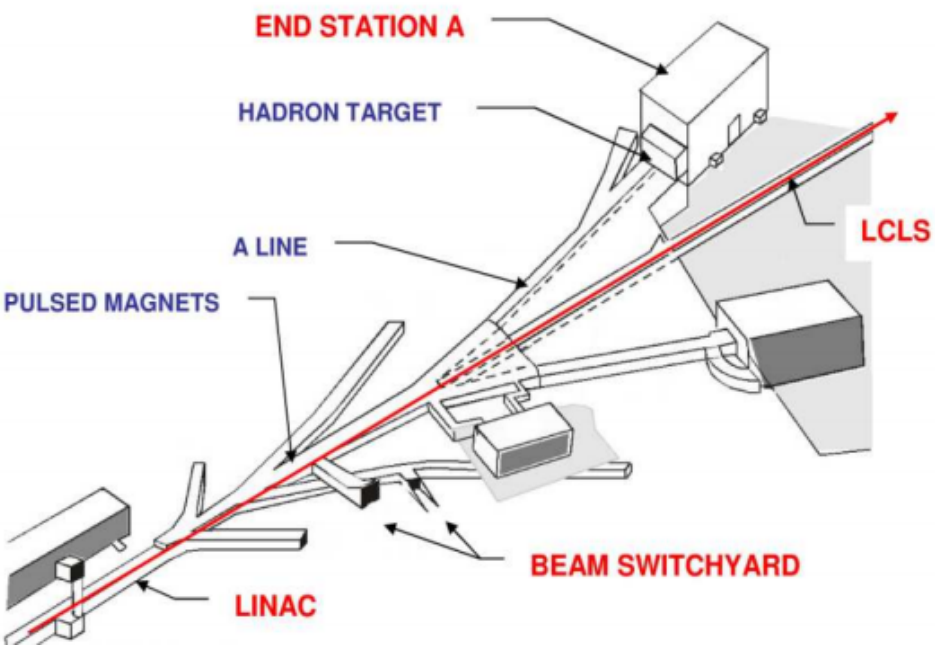




E. Kistenev, CALOR2014, 4/10/14

E. Kistenev @ BNL

ESTB—End Station Test Beam

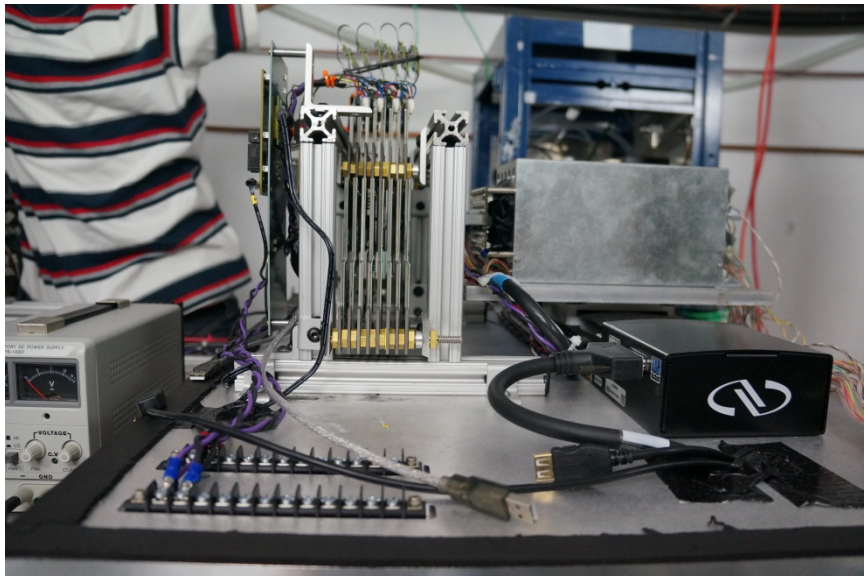


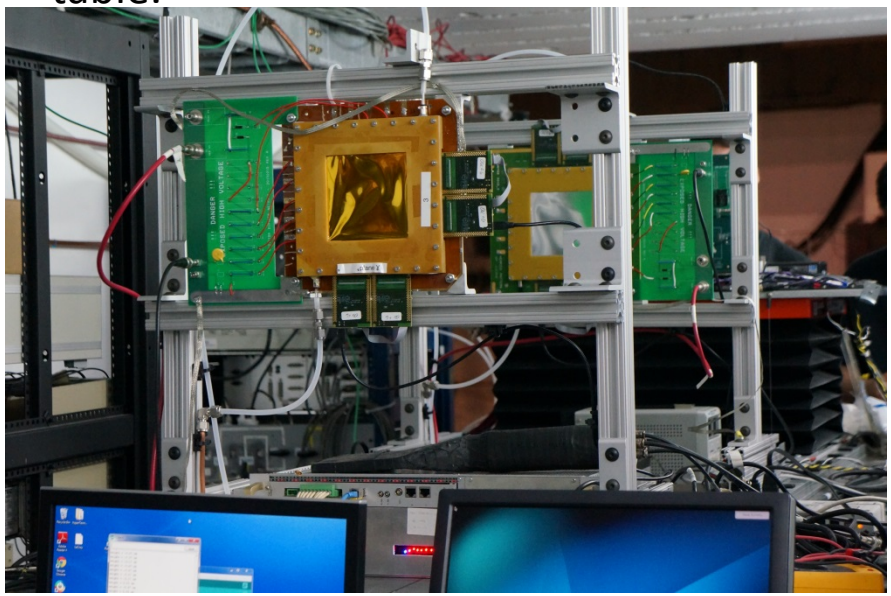
- SLAC feeds ~100 fsec electron pulses to Linear Coherent Light Source (LCLS) @ 120 Hz.
- Beam "kicked" onto Cu target @ 5 Hz.
- ESA tuned for $\langle N_e \rangle \sim 1.5$
  - ESTB delivers singles & pairs of EM showers.
  - Location(s) can be TRACKED!
  - Ideal facility for MPC-EX testing.

T. Hemmick @ SBU

SLAC MPC/MPC-EX

- Pre-shower detector (MPC-Ex) in the front, eight layers of W-Si
- The EM Calorimeter (MPC) in the back on a horizontal mover.
- MPC moves horizontally via Newport Trans. Stage.
- System moves up/down via scissor lift table.

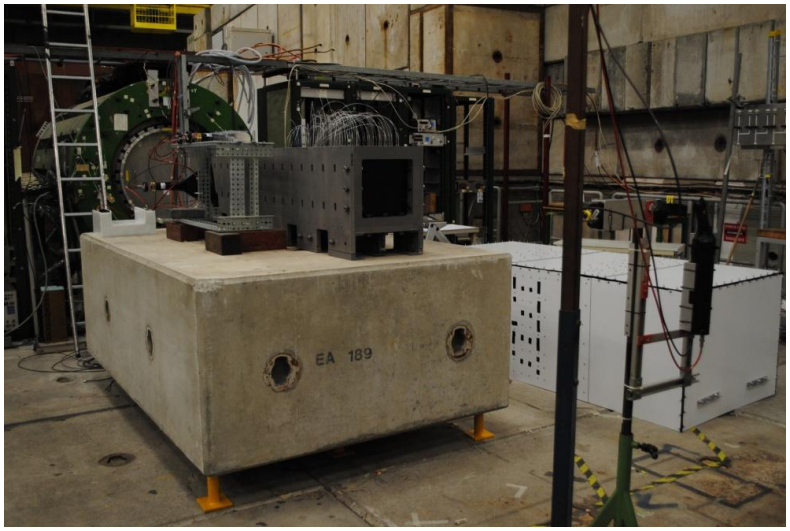


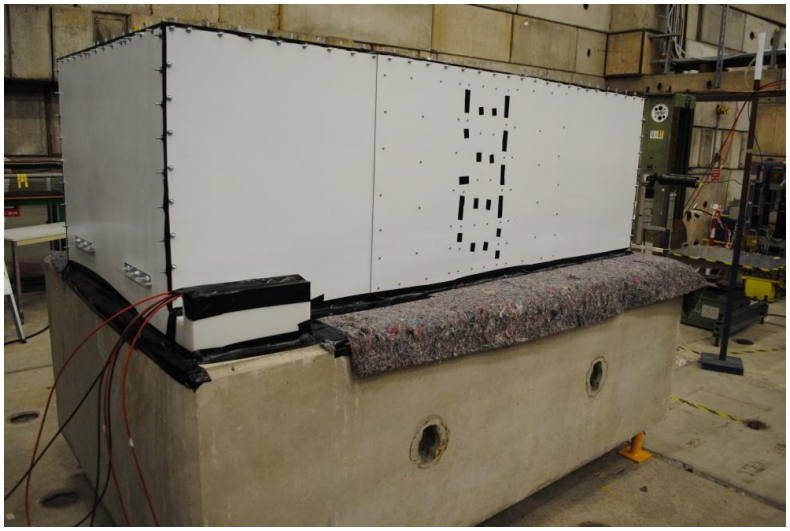


- The two GEM trackers in front of the MPC-Ex and MPC.
- Constructed from left-over parts from SBU/BNL/Uva…

T. Hemmick @ SBU

CERN PHENIX HCal Test Beam





Measure performance of Hcal module for PHENIX upgrade.
Located in T9 Beamline at CERN PS
Ran with hadrons and muons
Energy range GeV-10 GeV
7 days of running, Dec 2012
Multiple detector configurations

J. Frantz @ OSU

BNL Test Beam Requirements

- Particles: muons, pions, electrons, protons
- Range of Energies: < 1 GeV to 20 GeV
- Variable intensities: Few Hz to 10s of KHz
- Variable beam spot: 1 cm^2 to a few cm^2
- Ability to "scan" the beam
- Controlled access to equipment in the beam line
- Multiple setup locations

Test Beam Infrastructure

- Flexibility
- Tech Support
  - Mechanical
  - Electronics
- Rapid Safety Reviews
- Beam line detectors
  - Tracking
  - Particle ID
  - triggering
- Support electronics
- Networking and local computing
- Lift tables
- Rigging
  - Overhead cranes
  - Fork lifts
- User Friendly

Conclusions – I

- Most test beam efforts are:
  - Small groups, < 20 people
  - "Table Top" detectors
  - Run for a short periods, < month
  - Run multiple times over a period of months or years
  - Require strong technical support and facilities

Conclusions - II

- RHIC/eRHIC groups have a demand for test beams.
  - Calorimetery
  - Tracking
  - PID
- A good test beam facility will:
  - Offer wide range of beam energies
  - Have mixed particle options: e/μ/π/p
  - Have good technical support
- A BNL Test Beam would be a strong asset for BNL and C-AD